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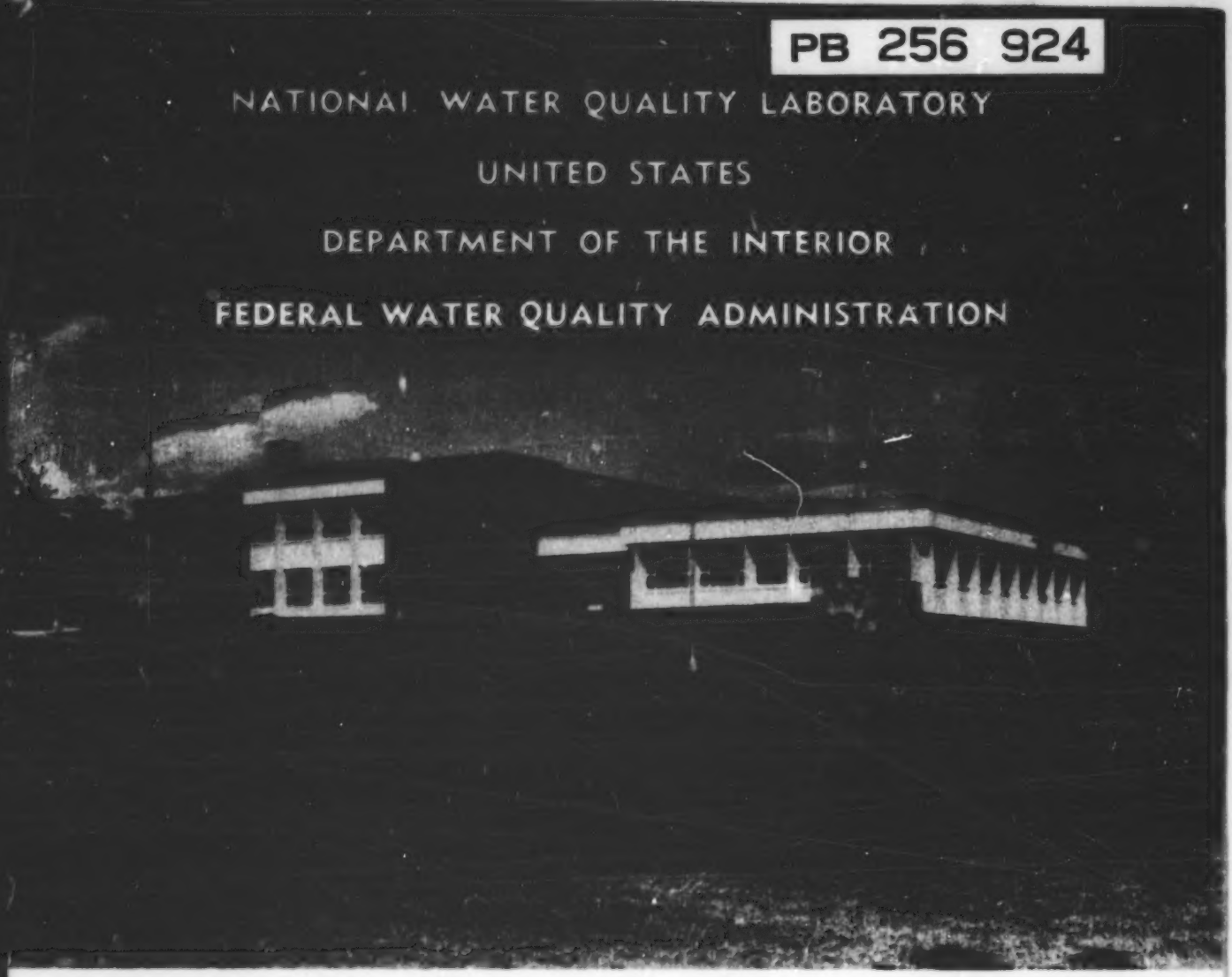

NATIONAL WATER QUALITY LABORATORY

UNITED STATES

DEPARTMENT OF THE INTERIOR

FEDERAL WATER QUALITY ADMINISTRATION

A MODULAR CONTROLLED-TEMPERATURE APPARATUS FOR FISH EGG INCUBATION AND FRY REARING

J. Howard McCormick and Roll F. Syrett

November, 1970

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16. Abstracts

The report describes a modular controlled-temperature apparatus for fish egg incubation and fry rearing. The apparatus described constructed on a modular basis provides continuous flow of water at constant temperatures for experimental work with fish eggs and fry. Each module provides one test temperature, which is controlled with a thermoregulator and immersion heater in each headbox. Flow is regulated by headbox elevation and orifice size.

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*Aquaculture
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Thermoregulation
Eggs
Submerging
Heating equipment
Reproduction(Biology)
Survival
Growth
Acceptability

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Continuous flow

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A Modular Controlled-Temperature Apparatus for Fish Egg Incubation and Fry Rearing

J. Howard McCormick and Roll F. Syrett

U. S. Department of the Interior

Federal Water Quality Administration

National Water Quality Laboratory, Duluth, Minnesota

ABSTRACT

McCormick, J. Howard and Roll F. Syrett (National Water Quality Laboratory, FWQA, Duluth, Minnesota). A modular controlled-temperature apparatus for fish egg incubation and fry rearing.

The apparatus described constructed on a modular basis provides continuous flow of water at constant temperatures for experimental work with fish eggs and fry. Each module provides one test temperature, which is controlled with a thermoregulator and immersion heater in each headbox. Flow is regulated by headbox elevation and orifice size.

McCormick and Syrett

A Modular Controlled-Temperature Apparatus for Fish Egg Incubation and Fry Rearing

Tests to determine acceptable constant temperatures for embryogenesis, hatching success, and survival and growth of fish fry are being conducted at the National Water Quality Laboratory with the apparatus described below. The apparatus which is relatively inexpensive, dependable, and convenient to work with, is constructed on a modular basis with each module providing one test temperature. A module includes a stainless steel headbox which contains a float valve, an immersion heater, and a thermoregulator; a manifold which splits flow three ways for duplications of tests; containers for egg incubation (Figure 1); rectangular glass containers for fry bioassay and fry rearing (Figure 2); and temperature measurement and recording equipment. The estimated cost of materials per module is about $200.00, excluding temperature recorders.

We wish to thank W. F. Dawson who developed the modification of the relay system, and D. I. Mount, B. R. Jones, K. E. F. Hokanson, and C. B. Kleiner who provided guidance and assistance.

Temperature Control

The temperature control system (Figure 4) consists of an adjustable mercury contact thermoregulator whose signal passes through a modified mercury relay to an immersion heater. A pilot lamp permits rapid monitoring of the system. Water entering the headbox is heated to test temperature by a stainless steel immersion heater (Figure 5) selected to provide adequate heat with little excess capacity. Such selection of heater wattage prevents excessive override of temperature and limits the maximum temperature reached in case of control failure. The thermoregulator should be located in the headbox to allow temperature override to modulate before the water is delivered to the test units. The relay is modified (Figure 4) by (1) removal of the resistor, (2) installation of a static bleed wired to the relay shield, and (3) installation of a delay relay tube. Modification reduces the incidence of failure of this element. An alarm system is, however, suggested employing two aquarium type thermostats installed in each headbox, one set to open just above the module control temperature, the other set to close just below the control temperature and circuited so that when either the low one closes

or the high one opens an alarm is energized.

To obtain water which is colder than the incoming supply, a chilling system is added to the module. Incoming water is chilled with a cooling unit with its stainless steel coil placed in a separate reservoir, from which the water is delivered to the headbox. Aeration of the chilling reservoir reduces icing on the cooling unit coil.

Flow Regulation

The flow of water through each module is from headbox to egg-incubation unit to fry-study units to drain. Details relating to flow regulation and arrangement of components in the headbox and incubation jar are shown in Figures 4 and 5 respectively. Water is delivered from the headbox through the manifold to three feed lines. Locating the headbox outlet about 2 inches above the bottom allows particulate material in the incoming water to settle out. Properly sized tubing eliminates air blockage between the manifold and incubation jars.

The rate of flow (250 milliliters per minute has been used) is adjusted by elevation of the headbox and bore size of the capillary tube. Flow has

also been regulated with a fixed orifice tube made by drawing out a piece of standard glass tubing to a fine tip and grinding it off until an orifice size is obtained which provides the desired flow rate. The capillary tube has the advantage of being considerably more resistant to breakage, the drawn tubing is easier to keep clean; either reduces the potential plugging problem of needle valves.

To avoid agitation during sensitive stages of embryogenesis the eggs are suspended on a stainless steel screen (Figure 6). Silicone rubber adhesive on the edge of the screen creates a tight fit in the jar and around the standpipe. However, if rolling is desirable, the eggs are placed directly in the bottom of the jar without the screen. The degree of turbulence can be regulated by raising or lowering the tip of the flow regulator with the level adjustment (Figure 6).

As the water flows from the incubation unit through the fry-study units an uncontrolled adjustment in temperature toward room temperature takes place. To minimize this change, usually less than 1° C. except at extreme temperatures, insulation can be installed around the fry-study

units and the flow rates can be increased.

Construction Information

Details of construction of chambers for holding test lots of fry as a group or individually, if the fry are small and difficult to see, are shown in Figure 7. Details of construction of the movable screen and outlet of the fry-rearing unit are shown in Figure 8. Dimensions of the headbox are 12 by 12 by 15 inches high. Dimensions of the rectangular bioassay and fry-rearing units (Figure 2) are 4 by 4 by 6 inches and 4 by 4 by 16 inches, respectively. The bioassay and fry-rearing units are constructed of single-strength window glass glued with silicone rubber adhesive.

Electrical grounding is essential to safe operation, as is buffing of glass edges. Polyvinylchloride and stainless steel pipe and pipe fittings are used to avoid interference by toxic metallic ions. Tygon tubing is used because rubber is toxic to some aquatic organisms (Hubschman and Engle, 1965; Biesinger, 1969 [1]). For the same reason neoprene stoppers are used instead

[1] Personal communication

of rubber stoppers. Rigid plastic tubing is less hazardous to work with and more durable than glass tubing for headbox airstone installations. Treatment with boiling water permits molding this tubing to shape and ice water will fix its configuration. Vigorous aeration is required to prevent supersaturation with gases and thermal stratification in the heated water of the headboxes (Pavley and Nakatani, 1967). An oil-free compressed air supply is necessary and may be obtained from an oil-free compressor or by installing oil filters in the air lines.

Holes in the plastic petri plate are made with a cork borer. Holes in the glass test units are drilled with a water-cooled diamond impregnated tube drill or a carbide glass drill lubricated with turpentine.

Table 1 -- Description and sources[1/] of items, other than the common laboratory, plumbing and electrical materials, referred to in the text and figures:

Tele-thermometers, recorders, and thermistors:
Yellow Springs Instrument Co.
Yellow Springs, Ohio

Stainless steel tubing:
Jos. T. Ryerson & Son, Inc.
Chicago, Illinois

Thermoregulators "Micro-set" type:
Precision Scientific Co.
Chicago, Illinois

Plastic Toilet reservoir valve and level float. Sears No. 42 2103 (brass components in contact with water replaced by p.v.c. pipe) Styro foam float.

Immersion heaters - Rino Chromalox Immersion Element
E. L. Wiegand Co.
Pittsburgh, Pennsylvania

Mercury Relay, normally closed
H. B. Instrument Co.
Philadelphia, Pennsylvania

Delray relay, Amperite #115N02
Amperite Co.
Union City, N. Y.

Silicon Rubber Adhesive
General Electric Co.
Waterford, N. Y.

Stainless Steel Screen
W. S. Tyler Co.
Mentor, Ohio

Nytex Screen
Tobler, Ernst, & Traber, Inc.
New York, N. Y.

Oil Filter for Laboratory Air Systems
Deltech Engineering, Inc.
New Castle, Delaware

Oil-free Air Compressor
Bell & Gossett
Morton Grove, Illinois

Blue M Cooling Unit with stainless steel coil
Blue M Electric Co.
Blue Island, Illinois

Glass cutting machine, 12 inch carborandum cutting wheel
No. 4-651-MI
Pistorus Machine Co., Inc.
Hicksville, N. Y.

Glass drilling tools
Sommer & Marca Glass Machinery Co.
Chicago, Illinois

1/ The FWQA neither recommends nor endorses any commercial product.

References to trade names and manufacturers of equipment have been listed only for identification.

REFERENCES

HUBSCHMAN, J. H., and R. A. ENGEL.

1965. Toxicity of rubber stoppers to Daphnia magna (Straus). Nature, Vol. 205, No. 4975, p. 1029.

PAVLEY, G. B., and R. E. NAKATANI.

1967. Histopathology of "gas-bubble" disease in salmon fingerlings, Journal of Fisheries Research Board of Canada, Vol. 24, No. 4, p. 867-876.

Figure 1. -- View of the apparatus showing headboxes, manifolds and incubation jars.

Figure 2. -- View of the apparatus showing arrangement of incubation jars, fry bioassay units, and fry rearing units.

Figure 3. -- Assembly drawing of one module.

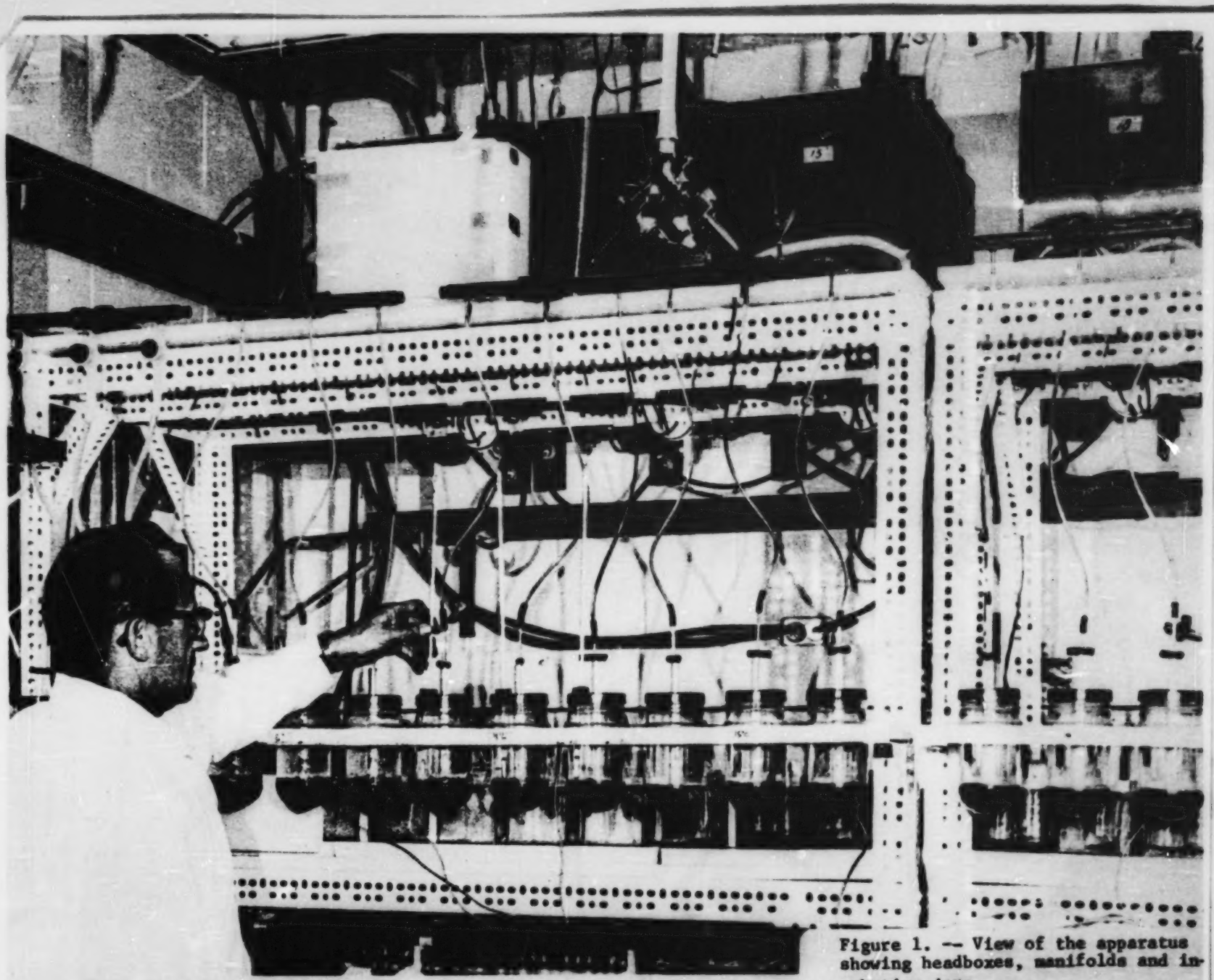
Figure 4. -- Temperature control system.

Figure 5. -- Headbox assembly.

Figure 6. -- Details of egg incubation jar constructed from a 6 1/2 by 3 inch vapor tight globe.

Figure 7. -- Bioassay test chambers.

Figure 8. -- Fry rearing unit.



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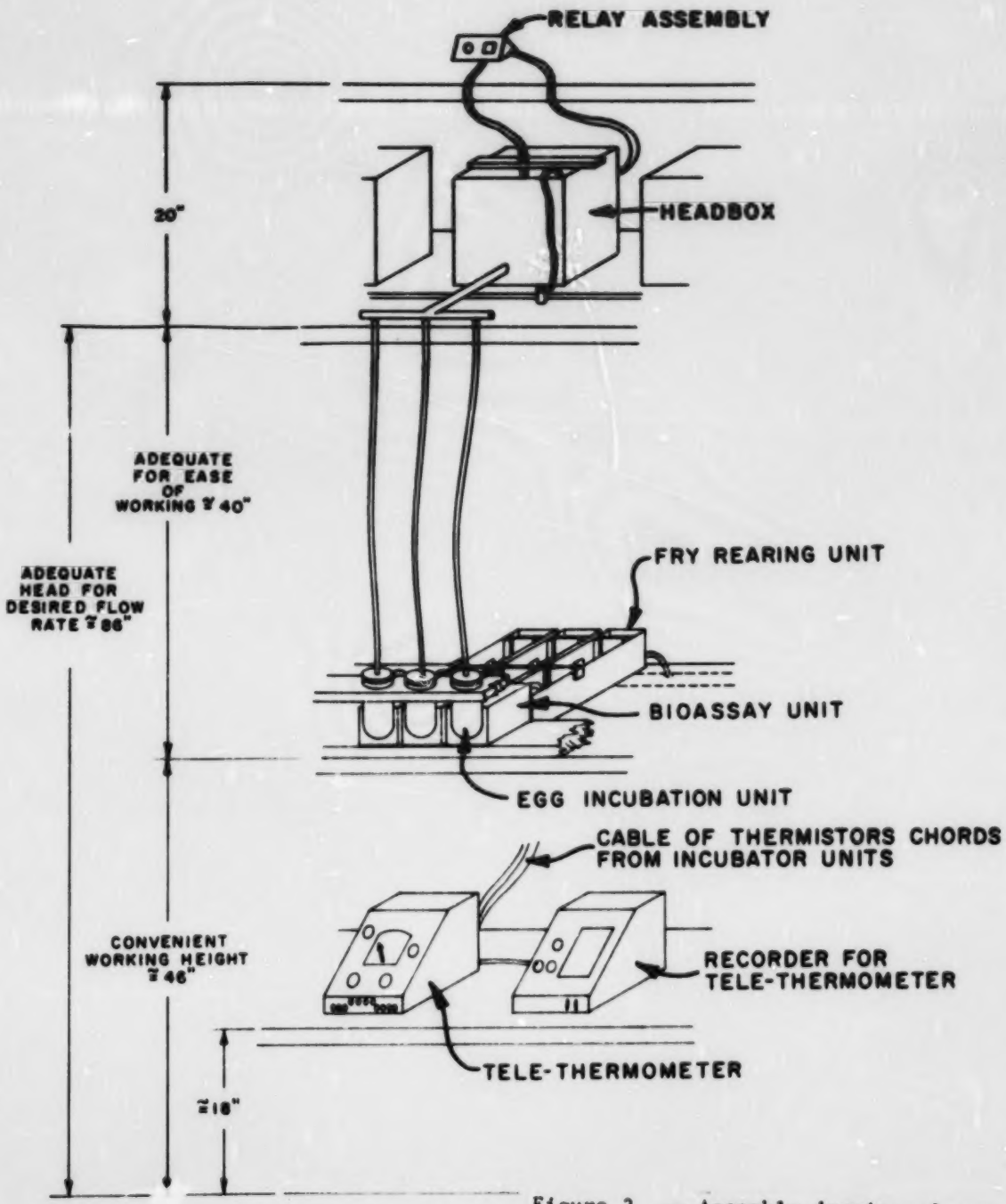


Figure 3. -- Assembly drawing of one module.

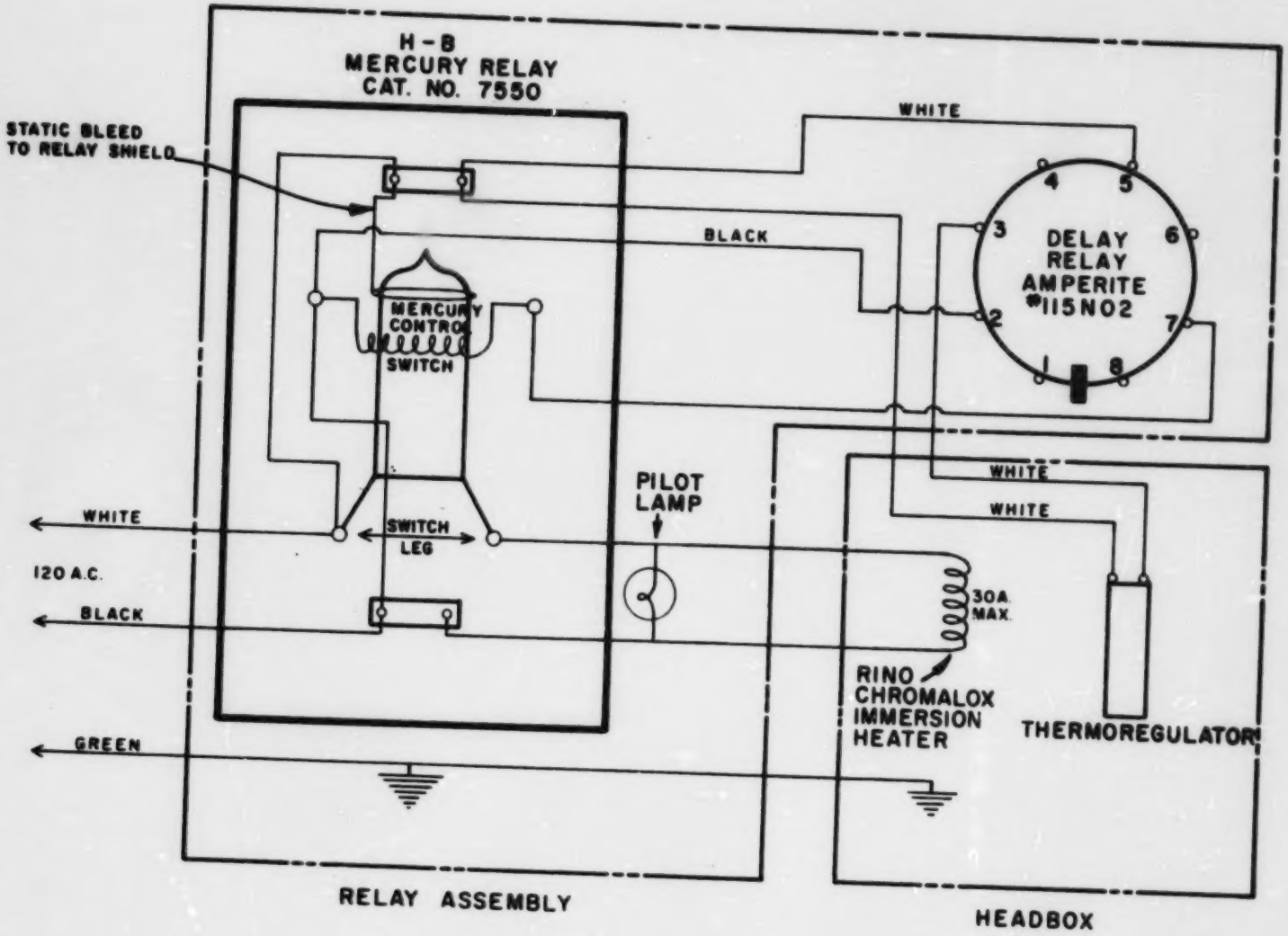


Figure 4. -- Temperature control system.

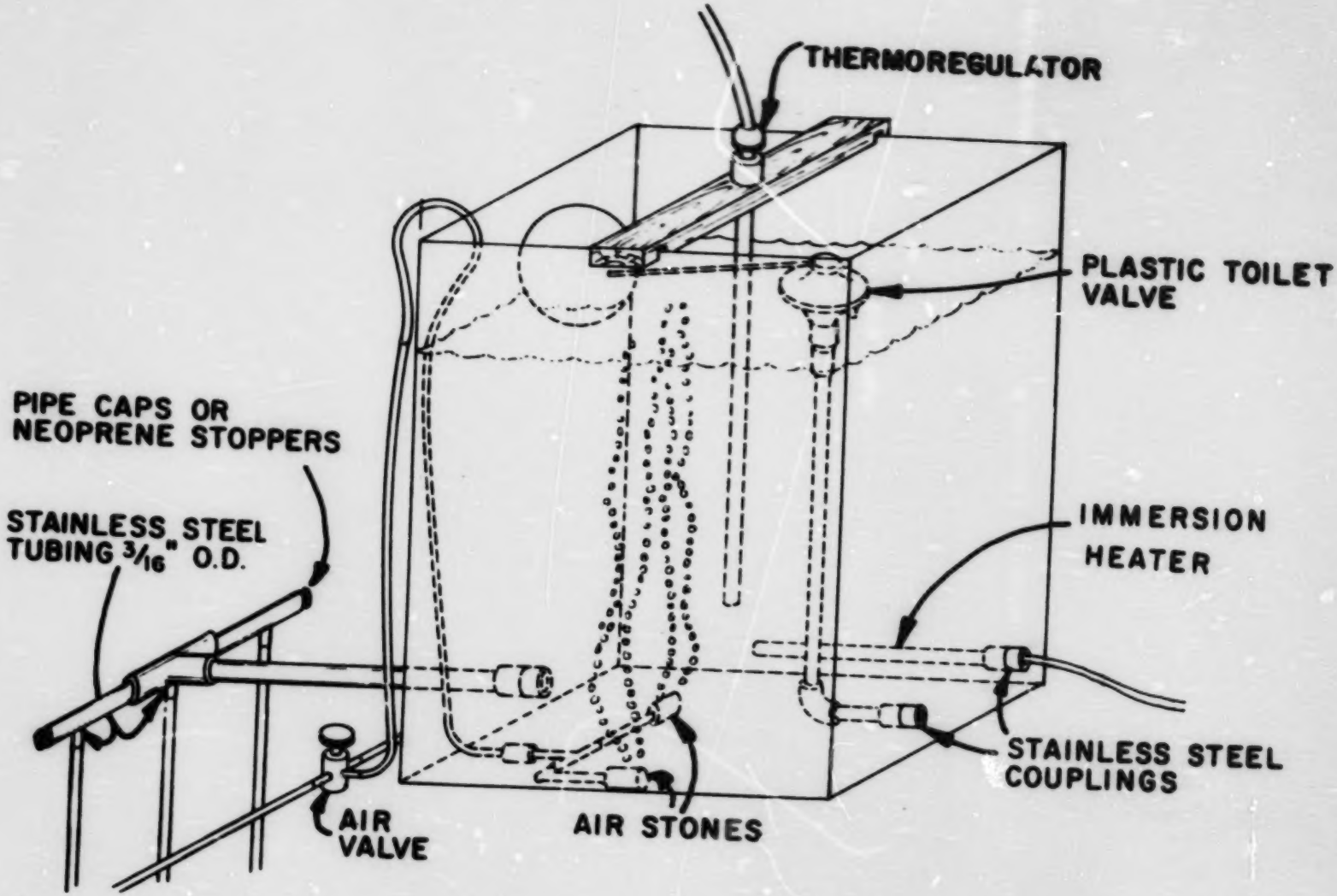


Figure 5. -- Headbox assembly.

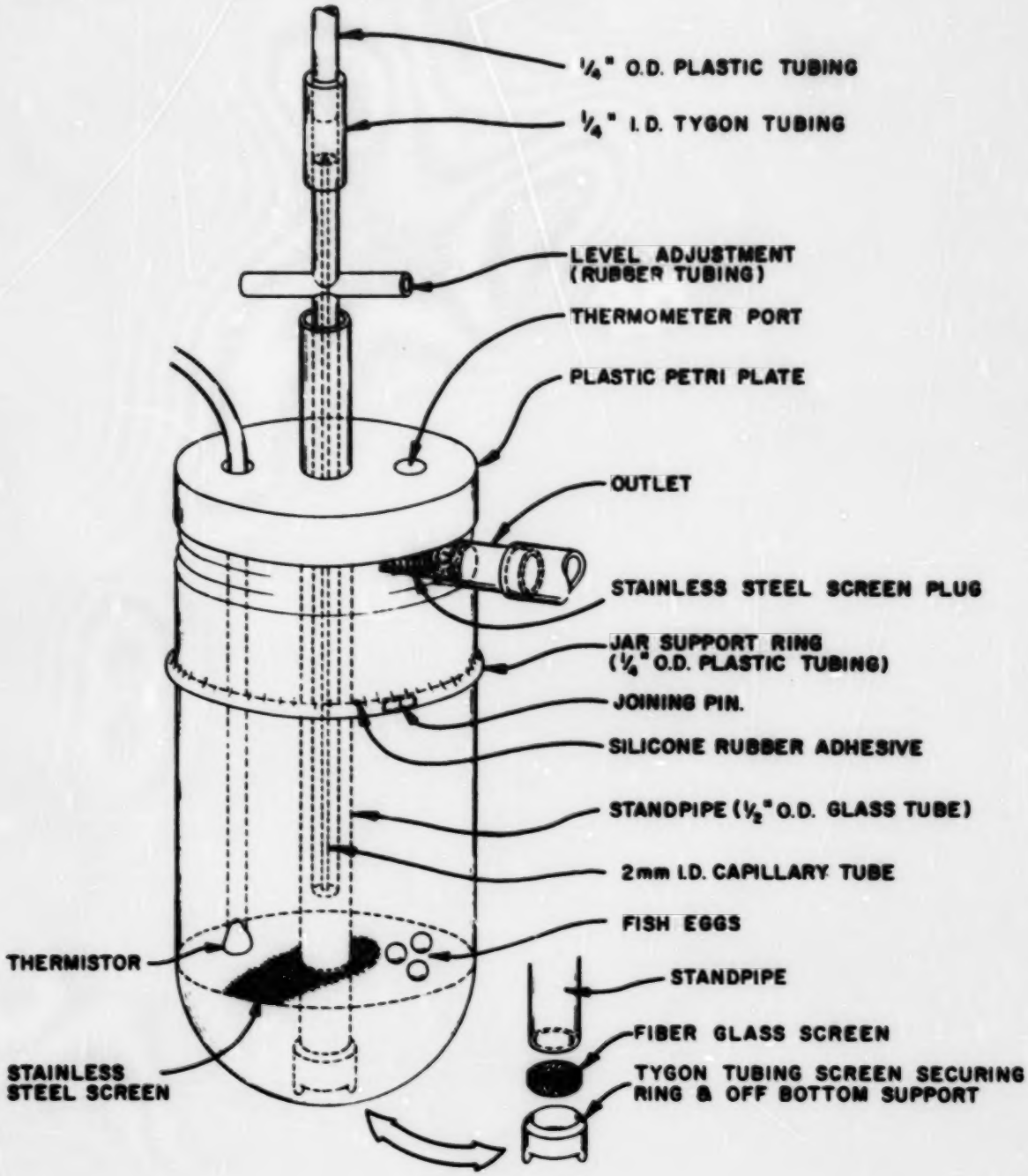
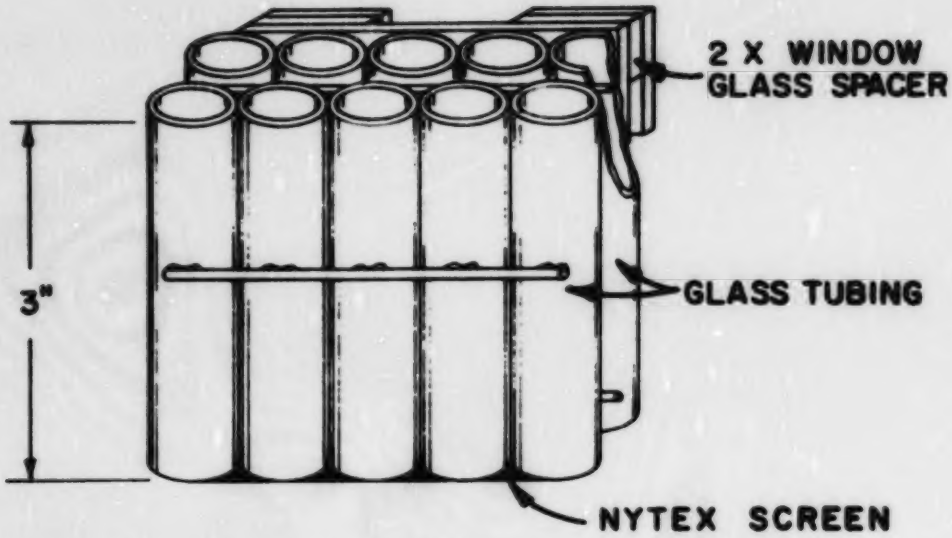
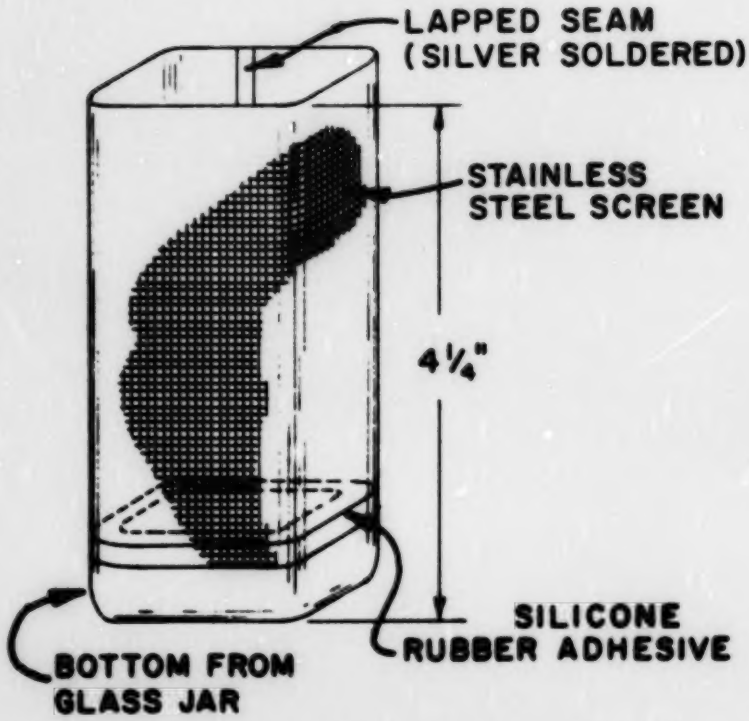


Figure 6. -- Details of egg incubation jar constructed from a 6 1/2 by 3 inch vapor tight globe.

Figure 7. -- Bioassay test chambers.



INDIVIDUAL CHAMBERS FOR SMALL FRY



SINGLE CHAMBER FOR LARGE FRY

Figure 8. -- Fry rearing unit.